

WHAT IS CLAIMED IS :

1. An apparatus for programmably generating an illumination pattern superimposed onto a substrate, said illumination pattern having a predetermined arrangement of light and dark zones, said apparatus comprising:
an illumination source;
a reconfigurable mask composed of an array of pixels, said pixels being actively controllable and directly addressable by means of a computer-controlled circuit and computer interface, said computer-controlled circuit being operated using a software program providing temporal control of the intensity of illumination emanating from each pixel so as to form the illumination pattern comprising the predetermined arrangement of light and dark zones;
a projection system suitable for imaging the reconfigurable mask onto the substrate; and
an imaging system incorporating a camera capable of viewing said substrate with superimposed illumination pattern.
2. The apparatus of claim 1, further comprising an image analysis system permitting acquisition of digitized images of the illumination pattern, analysis of said digitized images so as to extract feature vectors of interest, and thereby to permit creation of derivative patterns based on said feature vectors of interest.
3. The apparatus of claim 1, wherein said computer-controlled circuit and computer interface are capable of accepting input from a video display adapter.
4. The apparatus of claim 1, wherein said array of pixels is actively controlled so as to permit adjustment of variable and controllable levels of pixel transmissivity or reflectivity.
5. The apparatus of claim 4, wherein said array of pixels comprises a liquid crystal display or a digital micromirror device.

6. The apparatus of claim 1, wherein said software program provides a series of illumination patterns, said patterns being produced interactively in a graphical user interface software program or being replayed from a storage device containing previously produced patterns.
7. The apparatus of claim 1, wherein the substrate comprises a light-sensitive planar electrode, said light-sensitive electrode being aligned with another planar electrode in substantially parallel arrangement, with said electrodes being separated by a gap, and the gap containing an electrolyte solution which is in contact with said electrodes and which contains colloidal particles suspended at an interface between the light-sensitive electrode and the electrolyte solution, and wherein the illumination pattern is projected onto said light-sensitive electrode so as to control the assembly and lateral motion of said colloidal particles, said assembly and lateral motion being induced by a time-varying electric field applied between said electrodes.
8. An apparatus for programmably reconfiguring an array of particles on a substrate by programmable adjustment of an illumination pattern projected onto a substrate comprising:
 - an illumination source;
 - a reconfigurable mask composed of an array of pixels, said pixels being actively controllable and directly addressable by means of a computer-controlled circuit and computer interface, said computer-controlled circuit being operated using a software program providing temporal control of the intensity of illumination emanating from each pixel so as to form the illumination pattern comprising the predetermined arrangement of light and dark zones;
 - a projection system suitable for imaging the reconfigurable mask onto a substrate, wherein the substrate comprises a light-sensitive planar electrode that is aligned with another planar electrode in substantially parallel arrangement, with said electrodes being separated by a gap, and the gap containing an electrolyte solution which is in contact with said electrodes and which contains colloidal particles suspended in the electrolyte solution; and

an imaging system incorporating a camera capable of viewing said substrate with superimposed illumination pattern.

9. A process for using a programmable illumination pattern generator so as to provide active feedback in the optimization of an illumination pattern prepared by said pattern generator, said process comprising:
 - creating a predetermined illumination pattern;
 - configuring programmable illumination pattern generator in accordance with said predetermined illumination pattern;
 - illuminating a field of view on a substrate using a light source and a projection system using the programmable illumination pattern generator;
 - acquiring an image of the field of view;
 - analyzing said image so as to extract a set of feature coordinates within the image; and
 - iterating said creating, configuring, illuminating, acquiring and analyzing steps n times, wherein n is an integer from zero to 10,000, using said feature coordinates determined in the $(n-1)$ th analyzing step so as to create a derivative optimized illumination pattern.
10. The process of claim 9, wherein the predetermined illumination pattern is created within a graphical user environment.
11. The process of claim 9, wherein said configuration step is performed using a liquid crystal display panel.
12. The process of claim 9, wherein the programmable illumination pattern generator comprises an active mask which is configured by means of a video adapter interfaced with an active mask control circuit.
13. The process of claim 9, wherein the active feedback is used to programmably reconfigure an array of particles assembled on the substrate in accordance with claim 15.

14. The process of claim 13, wherein said particles are being reconfigured by applying a segmentation operation, said operation producing at least two subarrays.
15. The process of claim 9, wherein the active feedback is used to optimize the configuration of an assembled particle array by iterating the operation of array segmentation.
16. A programmable patterning device for generating a chemically patterned surface or surface coating comprising:
 - an apparatus for programmably generating an illumination pattern having a predetermined arrangement of light and dark zones on said surface, the apparatus comprising:
 - an illumination source;
 - a reconfigurable mask composed of an array of pixels, said pixels being actively controllable and directly addressable by means of a computer-controlled circuit and computer interface, said computer-controlled circuit being operated using a software program providing temporal control of the intensity of illumination emanating from each pixel so as to form the illumination pattern comprising the predetermined arrangement of light and dark zones;
 - a projection system suitable for imaging the reconfigured mask onto the surface; and
 - an imaging system incorporating a camera capable of viewing said substrate with superimposed illumination pattern; and
 - a means for permanently altering a physical-chemical property of a light-sensitive surface or surface coating by exposure to light of pre-selected spectral composition in accordance with a programmed illumination pattern.
17. The device of claim 16, wherein the physical-chemical property comprises solubility in a pre-selected solvent so as to generate said chemically patterned surface or surface coating by exposure of the surface to said solvent.
18. The device of claim 16, wherein the physical-chemical reactivity comprises chemical

reactivity so as to generate said chemically patterned surface or surface coating by subsequent functionalization of the surface by chemical reaction.

19. The device of claim 16, wherein the spectral composition contains the wavelength of the visible spectrum.

19. The device of claim 16, wherein the spectral composition contains the wavelength of the visible spectrum.